Gendered Access to Land and Household Food Insecurity: Evidence from Nigeria

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Abstract

With rapid population increase and persistent climate stressors, access to arable land, and gender-based prejudice is a major worry. This paper investigates the joint influence of land access and gender on food insecurity using Nigerian data. Employing a logit model, findings show that while increase in land access reduces food insecurity, female-headed households were more food insecure. With a one-acre increase in land accessed, the likelihood of female-headed households being food insecure decreased by 16% compared to male-headed households. Our results provide policy insights on how improving access to land for female-headed households may sustainably enhance food security in Nigeria.

Keywords: Food security; Gender; Households; Land access; Nigeria.
JEL Code: Q12, R20, Q15, J16

1.0 Introduction

Ensuring food security remains a major concern in most developing countries. Although, globally more food is produced than the world's population needs, close to half ends up as food waste (FAO 2011a, Lundqvist, de Fraiture, and Molden 2008), while millions of people are left without adequate food especially in sub-Saharan Africa (Lundqvist, de Fraiture, and Molden 2008, FAO 2017). Given the importance of land as a key factor of agricultural production, it is necessary to ascertain if there is enough access to land for agricultural activities, especially because the majority of food producers in the developing world are smallholders, the bulk of which are women. Target 5A of the fifth Sustainable Development Goal (SDG) identifies the need to undertake changes that provide women equal rights, access, and opportunities to financial services and productive resources, like land, in accordance with the current national laws. According to several studies carried out in developing countries, women having equal access to productive resources will have a positive effect on the well-being of their household members as well as their health and education (Handa 1996, Rogers 1996, Duflo and Udry 2004, Kennedy and Peters 1992, Doss 1997). Unfortunately, in most developing countries, women and female-headed households have more barriers in accessing land than their counterparts (Wineman and Liverpool-Tasie 2017, Dokken 2015, Murugani et al. 2014, Khalid, Nyborg, and Khattak 2015, Brück and Schindler 2009). Often this obstacle is not just the area of land they access, but also its quality and how productive they can make it (Gill 1988, Quisumbing et al. 1998).

With the increasing significance of the role of women in securing the nutritional status of their households (FAO 2011b, Karl 2009, Levin et al. 1999, Quisumbing et al. 1998), determining the influence of gender-specific access to land on food security is crucial. In addition, the impact of gendered access to land on the food security of households is necessary to aid understanding of

factors affecting agricultural production and the ways it can be improved. It will also inform the enactment of policies to improve interventions for ensuring food security and improved livelihoods for rural dwellers.

Several studies have identified the distinctions in the food security status of male and female-headed households (Akadiri, Nwaka, and Jenkins 2018, Tibesigwa and Visser 2016, Mallick and Rafi 2010, Joshi and Joshi 2017). Other studies have examined differences in gendered access to land (Khalid, Nyborg, and Khattak 2015, Adelman and Peterman 2014, Lambrecht 2016, Wineman and Liverpool-Tasie 2017, Tran et al. 2013), but there still exists a gap in the literature on the effect of gendered access to land on food insecurity. To the best of our knowledge, no study has examined the combined effect of land access and gender of household head on the food insecurity of rural households. Understanding the relationship between access to land and food security is of vital importance for implementing development policies in most developing countries since the majority of rural dwellers are primarily involved in agriculture. Hence, there is little or no empirical evidence showing clearly the connection between gendered access to land and food insecurity in Nigeria.

The main objective of this study is to examine the joint effect of gender and access to land on household food insecurity. To achieve this goal, we use data from the 2015/16 Nigerian General Household Survey (GHS) and logistic regression analysis. In Nigeria, most of the studies on food security have been confined to certain states and districts and not the entire country (Iruonagbe 2011, Arene and Anyaeji 2010, Amaza et al. 2006). Furthermore, most of the studies in Nigeria fail to empirically determine the association between gender, access to land, and food security (Chikaire et al. 2016, Adekola et al. 2013). Given the importance of land resources as well as the significant role women play in the well-being and nutritional status of their families, it is important to understand how and to what extent access to land can influence the effect of gender of household head on food insecurity.

This paper has several contributions. First, we go further than current literature by quantifying the joint impact of land access and gender of household head on the food insecurity status of households. Therefore, we test whether increased access to land for female-headed households will have an influence on their food insecurity status. Second, the study enhances understanding of the mediating effect of land access on the influence of gender of household head on food insecurity. Finally, findings of this study will provide significant insight into strategies that focus on enhancing food security.

The rest of the article is organized as follows. The next section presents a summary of relevant literature on gendered land access and food security. After which a conceptual model linking household and household head characteristics to food insecurity and an empirical model is presented. Detailed descriptive analysis of the data is reported next. The subsequent section reports the estimated results, followed by a discussion of results. Finally, concluding remarks is presented.

2.0 Literature Review

2.1 Food Security and Access to land

Food security occurs when people have access to adequate, healthy, and nutritious food at all times that meet their nutritional needs and preferences (FAO 2017, 2006, Sasson 2012). Food insecurity is of great concern in both developed and developing countries though worse in the latter (Sasson 2012). In sub-Saharan Africa, insufficient food production as a result of the adverse effects of climate change was found to be the major cause of food insecurity, though conflicts and soaring food prices are contributing factors.

Increased access to land has been found to have a positive influence on household food security (Jayne et al. 2003, Rammohan and Pritchard 2014, Muraoka, Jin, and Jayne 2018), though income on owned land was found to be higher than that of rented land (Muraoka, Jin, and Jayne 2018,

Abdulai, Owusu, and Goetz 2011, Ali, Abdulai, and Goetz 2012, Abdulai and Goetz 2014). Tenure security influences the household's right to use, manage, and control land and its resources (Holden and Ghebru 2016). It has been found to have a clear and positive impact on land rights, agricultural productivity, and hence household food security (Deininger and Jin 2006, Ghebru and Holden 2013a, Holden and Ghebru 2016). If total food production is a key factor affecting the food security of developing countries (Sasson 2012), then tenure security and the resulting area of land accessed is key in determining the influence of land access on food security of households in these countries. Disparities in access to productive resources like land can make the difference between a food secure and a food-insecure household, whilst variation in the ability of different genders to access land will have a further influence on food security.

2.2 Gender and food security

Many studies have sought to determine the influence of the gender of household head on the household's food security status. Male-headed households (MHH) were found to be more food secure than Female-headed households (FHH) in Nigeria, Ethiopia, Nepal, Kenya and South Africa (Tibesigwa and Visser 2016, Joshi and Joshi 2017, Akadiri, Nwaka, and Jenkins 2018, Kassie, Ndiritu, and Stage 2014, Maharjan and Joshi 2011, Larson, Castellanos, and Jensen 2019). On the other hand, in a study by Mallick and Rafi (2010) in Bangladesh, no significant difference between the food security of male and female-headed households was found. The authors suggest that the lack of evidence on the difference could be as a result of a lack of socio-cultural restrictions among indigenous ethnic groups, permitting women more freedom to participate in the labour market. In addition, they suggested that another reason was that female-headed households' were given priority during food redistribution by informal institutions, for example, '*Khiang*' in indigenous communities. The authors also used a subjective measure of food security i.e. perception of

respondents about their household's food security, which can be a potential limitation given evidence of gender-based differences in perceptions of food security.

Some of the main reasons given for the variation in food security status of female-headed households compared to their male counterparts are inadequate access to productive resources, over-reliance on household food production, lower assets and off-farm income (Tibesigwa and Visser 2016, Joshi and Joshi 2017, Iruonagbe 2011). Kassie, Ndiritu, and Stage (2014) also found land quality and social capital to have a positive influence on female-headed household's food security. Belonging to a farmers' group and being connected with more traders in their neighbourhood increased the likelihood of food security for female-headed households. These farmer groups may provide financial support, access to improved input, and extension services, which in turn increases the productivity of female farmers.

3.0 Conceptual Framework

3.1 Conceptual model linking gender, land access and food security

Figure 1 presents our conceptual model linking gender, land access, and food security. It highlights that social and demographic factors like age, education of household head, and social networks influence household food security (Joshi and Joshi 2017, Akadiri, Nwaka, and Jenkins 2018, Rammohan and Pritchard 2014, Brück and Schindler 2009, Kassie, Ndiritu, and Stage 2014). Material assets of the household (Joshi and Joshi 2017), farm income, (Joshi and Joshi 2017, Akadiri, Nwaka, and Jenkins 2018), off-farm income (Tibesigwa and Visser 2016), location of household (Tibesigwa and Visser 2016), as well as the infrastructure available to household also influence food security.

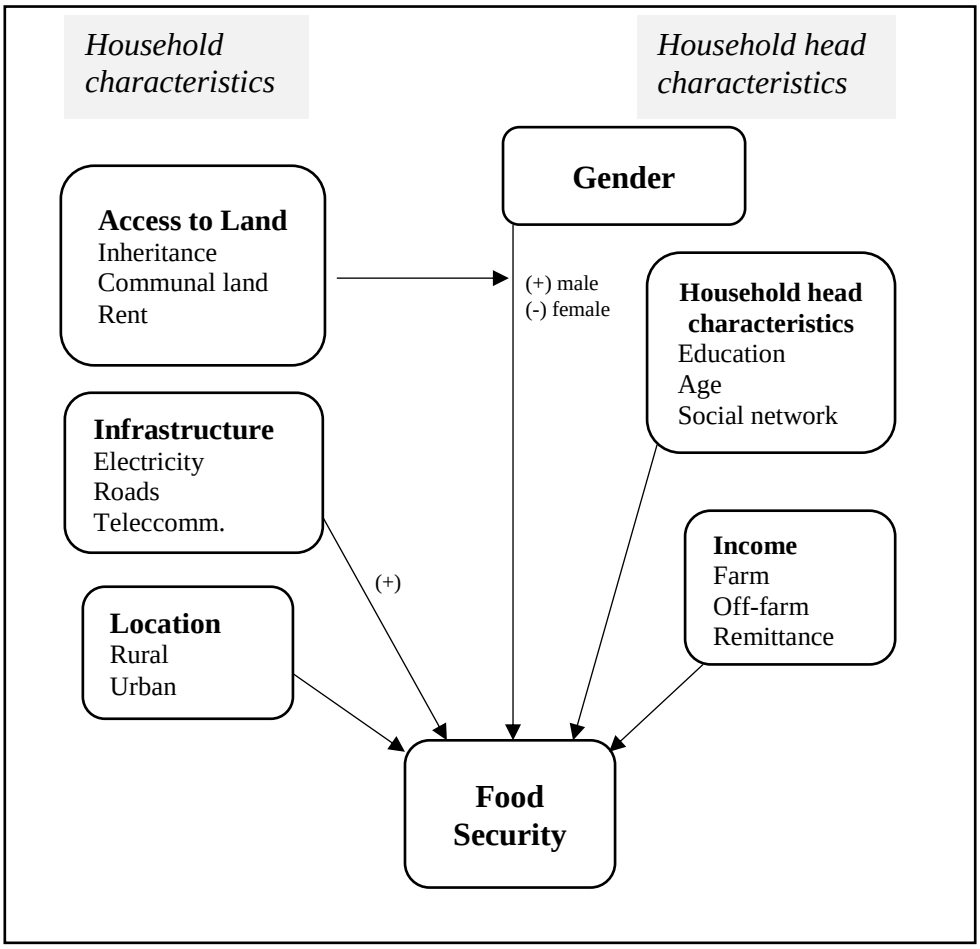

Figure 1. Conceptual model linking household and household head characteristics with food security

The most important determinant for food availability is land access (Kassie, Ndiritu, and Stage 2014, Muraoka, Jin, and Jayne 2018), which is the focus of our paper. In the conceptual framework (Figure 1), we define three ways to access land; inheritance, rent, and communal land. Among the household characteristics, we consider gender as one of the most important determinants of food security as in most developing countries, households with female heads are usually disadvantaged compared to their counterparts in the access and use of productive resources like arable land (Brück and Schindler 2009, Agarwal 2003, Lambrecht 2016, Adekola et al. 2013). This is mainly because

of cultural norms impeding women from gaining equal access to land. Some communities, especially patriarchal ones, do not allow women to inherit land; women only have access to land through their husbands and (or) male relatives (Khalid, Nyborg, and Khattak 2015, Chikaire et al. 2016). Sometimes, existing norms and culture inhibit women from having adequate access to land. For example, in some parts of Ethiopia, it is taboo for women to plough (Dokken 2015). Murugani et al. (2014) report that married women have more secure land access than single women, though most times, they do not own the land (Iruonagbe 2011). In developing countries, especially in patriarchal societies, women get access to land through their husbands when they are married and, if unmarried, through their male relatives (father, brother, etc.). In the case of communal land, although it is in collective ownership, women are often disadvantaged in communal land allocation (Iruonagbe 2011). Land accessed through a third party usually has insecure tenure and can be reclaimed at any time (Murugani et al. 2014). This can have negative implications for their finances, as land without full rights cannot be used as collateral for credit facilities. In turn, this can lead to adverse consequences for their food security, as access to productive resource, like land, will have an effect on their scale of production as well as their productivity and output.

Figure 1 also reveals that three characteristics of household heads- education, age, and their social network influences household food security. It indicates that households with educated heads tend to be more food secure (Akadiri, Nwaka, and Jenkins 2018, Rammohan and Pritchard 2014). With a higher level of education, the household head will have more human capital, information, and skills needed to use the right inputs and therefore increase productivity. This may also improve off-farm work participation and hence they can generate more income to purchase food. Household social networks were found to increase FHH's food security (Kassie, Ndiritu, and Stage 2014). For example, Brück and Schindler (2009) found that households with heads in a position of authority in the community had more access to land.

Figure 1 also shows that farm size and availability of infrastructure influences food security. Farm size and land quality were found to improve female-headed household's food security status (Kassie, Ndiritu, and Stage 2014). Distance to the market has a negative effect on food security (Kassie, Ndiritu, and Stage 2014, Akadiri, Nwaka, and Jenkins 2018). Those further away from markets may be more limited in terms of both their information on prevailing prices and also their ability to sell and purchase food in the absence of efficient transport infrastructure. Electricity connection was found to be a positive influence on household food security (Faridi and Wadood 2010). It can be an indicator of household welfare and subsequent access to other resources. For example, the availability of electricity makes automated irrigation possible.

In our conceptual model, we also include household location as a determinant of food security. Tibesigwa and Visser (2016) found that the gap between the food security of both male-headed households and female-headed households is much wider in rural areas than in urban areas. This implies that female-headed households in rural areas with unequal access to land are more susceptible to food insecurity as the number of off-farm opportunities is greatly reduced. They rely on land for sustenance to a great extent.

4.0 Empirical model and Specification

We specify a binary logit model because the dependent variable, food insecurity is a dummy:

$$P(Y_i = 1|X_i) = \frac{e^{\alpha+\gamma T_i+\beta_i X_i}}{1+e^{\alpha+\gamma T_i+\beta_i X_i}} \quad (1)$$

where Y_i is a dummy that indicates whether or not households reduced meals in the last seven days because they did not have enough food; *Ti* is an interaction term for gender and cultivated land, $\boldsymbol{X_i}$ is a vector of household and farm-level explanatory variables. Based on the conceptual model, we include the following explanatory variables: household head characteristics (age, education,

gender), household characteristics (location, income, farm size, etc.) and zone dummies.[1] Thus, we estimate the following equation:

$$Y_i = \ln(\frac{p}{1-p}) = \alpha_0 + \alpha_1 HH\_land_t + \alpha_2 HH\_gender_t + \alpha_3 HH\_Gender * land_t + \alpha_4 HH\_age_t + \alpha_5 HH\_age_t^2 + \alpha_5 HH\_size_t + \alpha_6 HH\_loc_t + \alpha_7 HH\_edu_t + \alpha_9 HH\_farminc_t + \alpha_{10} HH\_nonfarminc_t + \alpha_{11} remit_t + \alpha_{12} HH\_Elec_t + \mu_t \quad (2)$$

where Y_i represents the likelihood of the household being food insecure and μ_i denotes the error term . Table 1 presents definitions and summary statistics for the variables in the model.

[1] We could not include a proxy for social network in this study because of absence of data in the Nigerian General Household Survey

Table 1 Variable definition and summary statistics

Variable	Definition	Mean	SD	Min	Max
Food insecurity	1 if household food insecure, 0 otherwise	0.264	0.441	0	1
Household head characteristics					
HH_Gender	1 if female, 0 otherwise	0.065	0.247	0	1
HH_age	Age of respondent (years)	50.96	12.923	23	103
HH_edu	1 for no education, 4 for tertiary education	1.062	1.146	1	4
Household Characteristics					
HH_loc	1 if rural, 0 otherwise	0.848	0.359	0	1
HH_land	Size of farmland (acres)	2.208	3.524	0	36.79
HH_size	Number of household members	6.931	3.153	1	22
HH_nonfarminc	Income from non-farm sources (NG~~₦~~1000)	32.06	103.54	0	2247.5
HH_farminc	Income from agricultural production (NG~~₦~~1000)	192.70	366.17	0	5,050
Remit	1 if household received remittance, 0 otherwise	0.961	0.192	0	1

Note: NG~~₦~~ is Nigerian currency; US$1 = NG~~₦~~360 in 2019; SD is Standard Deviation

5.0 Data and Descriptive Statistics

5.1 Data

We use data from the third wave of the Nigerian General Household Panel Survey (GHS) conducted in 2015/16 (NBS 2016). Data collection included three questionnaires (agriculture, household, and community) for both the post-planting and post-harvest periods. The GHS-Panel sample was selected from the 2010 GHS sample comprising about 22,200 households from 2220

Enumeration Areas (EA) and 60 Primary Sampling Units (PSU). For the panel component, 5,000 households from 500 EAs were chosen. Some key variables like the educational level of household head were missing from the first and second wave of the GHS-Panel, so the study makes use of the third wave alone. In the third wave of the GHS-Panel, only 4,581 households completed their questionnaires. After data cleaning, transforming, and selecting for key variables, the sample for the study reduced to 1,096 households from both urban and rural areas.

For the study, land access was captured by household's total area of cultivated land which has a mean of 2.208 acres and ranged from 0 to 36.79 acres (table 1). We use the sex of household head to examine gender differences influencing food insecurity. The gender variable takes the value of 1 for female-headed households and 0 for male-headed households.[2] We use a self-assessment measure of household food consumption to proxy food security. The food security measure used is an experiential indicator that is measured using days of food shortages. Household heads were asked if they had to reduce the size of meals eaten in their households because of insufficient food. The choice of this measure was informed by our focus on the food availability pillar of food security. It is a binary variable, with a mean of 0.264, that takes the value of one when household reported they had reduced the portion of meals consumed in their household in the last week (food insecure) and zero otherwise (if food secure) (Li and Yu 2010). All analyses were done using STATA 15 statistical software.

[2] The study does not capture possible intra-household gender impacts. This may be a limitation of the study because women in male and female-headed households may face different challenges (Doss and Morris, 2000). This suggests that obstacles women in male-headed households face in accessing land and other productive resources may be different from what women in female-headed households experience and this will have consequences for their food security.

5.2 Descriptive Analysis

After selecting for relevant variables, a descriptive analysis of the data shows that most of the households are male-headed (Table 2) with a greater share of the households residing in rural areas (Table 4). Table 2 reports that about 25% of households in the sample were food insecure in total, though there were differences between male and female-headed households. About 93% of the sample are male-headed households, with about three-quarters of them being food secure. In comparison, about 7% of the sample are female-headed households, with about 57% of them being food secure. More specifically, this means that about 24% of male-headed households and 43% of female-headed households in our sample were food insecure. The gender variable has a statistically significant positive correlation with the food insecurity variable (0.0968) at the 1% level of significance. This implies that female-headed households were more likely to be food insecure compared to male-headed households.

Table 2 Distribution of households by demographic characteristics and food security status

Gender	Age	Food Insecurity				Total	
		No		*Yes*		N	%
Male	50.57	781	76.27%	243	23.73%	1024	93.43%
Female	56.55	41	56.94%	31	43.06%	72	6.57%
Total		822	100%	274	100%	1096	100%

Source: Authors' construction from survey data

Female heads were found to be older than male heads on average and also have much lower access to land.[3] A reason for the difference in age maybe because a majority of female heads were divorced and widowed compared to male heads, hence they were more likely to be older.[4] Similarly, Milazzo and Van de Walle (2015) and Ruwanpura and Humphries (2003) also found

[3] Tibesigwa and Visser (2016) also found female household heads to be older on average.
[4] In our sample, about 87% and 67% of widowed and divorced household heads respectively, were females.

female heads to be older, with the main cause of female headship being widowhood and divorce. Household size of female-headed households was almost 50% lower than that of Male-headed households on average. Oginni, Ahonsi, and Ukwuije (2013) and Milazzo and Van de Walle (2015) also found male-headed households were larger than female-headed households.[5]

Table 3 Mean characteristics of male and female-headed households

	N	Land size (acres)	Non-farm income	Farm income	Household Size
Male	1024	2.32	32730.74	202035.3	7.09
Female	72	0.48	22528.47	59929.17	4.62

Source: Authors' construction from survey data

Table 3 shows that on average, male-headed households were found to have about 3.4 and 1.4 times more farm and non-farm income than female-headed households, respectively.[6] A reason for the large difference in farm income between both types of households is that female-headed households generally have less access to agricultural land. Even in cases where they do have similar access, they may not have enough family labour, access to markets and input to cultivate their land productively.

Table 4 Distribution of households by Location and Gender

Location	Overall		Gender					
			Male			Female		
	n	% of total hh	n	%	%total hh	n	%	%total hh
Urban	167	15.24	153	14.94	13.96	14	19.44	1.28
Rural	929	84.76	871	85.06	79.47	58	80.56	5.29
Total	1,096	100	1,024	100	93.43	72	100	6.57

Note: hh denoted households

Source: Authors' construction from survey data

[5] Milazzo and Van de Walle (2015) also report female-headed households to have a higher dependency ratio than male-headed households, contrary to the finding Oginni, Ahonsi, and Ukwuije (2013).
[6] Agrees with finding of Kennedy and Peters (1992) and Akadiri, Nwaka, and Jenkins (2018).

Table 5 Distribution of households by household head educational attainment and Gender

Location	Gender					
	Male			Female		
	n	%	%total hh	n	%	%total hh
No education	287	28.03	26.19	22	30.56	2.01
Primary education	374	36.52	34.12	34	47.22	3.10
Secondary education	241	23.54	21.99	12	16.67	1.09
Tertiary education	122	11.91	11.13	4	5.56	0.36
Total	1,024	100	93.43	72	100	6.57

Note: hh denoted households

Source: Authors' construction from survey data

Table 4 presents a descriptive analysis of households by gender and location. Most households in the survey are in rural areas and are male-headed households. Table 5 illustrates that most household heads had primary education with relatively few male or female-headed households having tertiary education.

Table 6 shows descriptive statistics by geopolitical regions in Nigeria. Households in the northeast and the northcentral were found to have the largest access to land compared to households in the Southeast and South-south geopolitical zones. Figure 2 illustrates that the northern region makes up about two-thirds of the landmass of Nigeria, even though most of the population is situated in the southern region. Consequently, households in the Northern regions have more access to land than those in the south, as illustrated in Table 6. Also, households in the northern geopolitical zones, on average, have more household members than those in the south. In agrarian regions, this could signify more family labour which will reduce costs and increase productivity, but on the other hand, it could also imply more mouths to feed and subsequent lack of food.

Table 6 Demographic characteristics of households by geo-political zones

Zone	Mean			
	n	*Age (years)*	*Land size (acres)*	*Household Size*
North-central	140	47.87	3.63	7.58
Northeast	181	47.32	4.66	8.69
Northwest	272	47.69	2.14	8.31
Southeast	206	57.54	0.32	5.18
South-south	186	51.98	0.55	5.82
Southwest	111	54.95	2.80	4.95

Source: Authors' construction from survey data

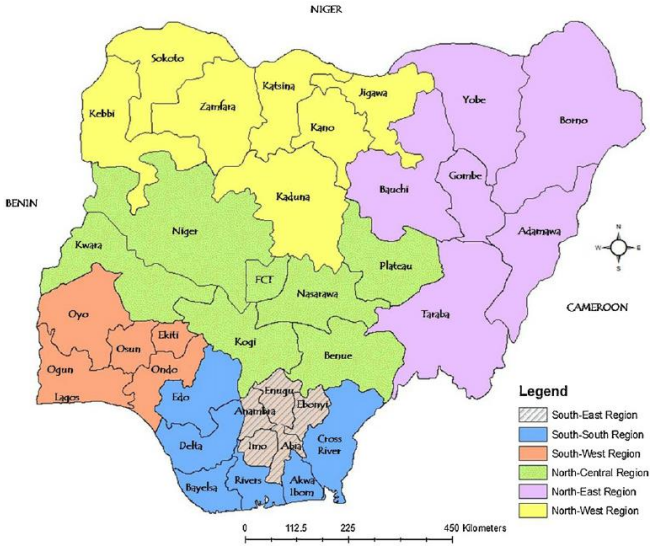

Figure 2 Map of Nigeria showing geopolitical zones.
Source: Ekong et al. (2012)

The average age of household heads is lower in the northern regions than in the Southern regions (Table 6). On average, households in the southeast geopolitical zone have the highest household head age, the smallest land size, and the second to smallest household size.

6.0 Results and discussion

6.1 Gendered Access to Land and Food security

We estimate equation (1) using a maximum likelihood estimator. The estimated coefficients in Column 2, Table 7 indicate that the gender of household head, area of land accessed, and educational level of household head was significant ($p<0.05$). Total farm income was significant at 1%, while household size and gender-land interaction variables were significant ($p<0.10$). Of the significant variables, area of land accessed, gender-land interaction, household size, and educational level negatively influenced food insecurity while the gender of household head and total farm income have a positive influence.

Table 7: Estimation Result of the food security model

Explanatory Variables	Model	
	Odds ratio	Marginal effect
Total land	0.929 (0.028)**	-0.015 (0.006)**
Gender (1=female)	2.066 (0.665)**	0.166 (0.079)**
Gender*land	0.325 (0.208)*	-0.227(0.129)*
Age	0.958 (0.033)	-0.009 (0.007)
Age squared	1.000 (0.0000)	0.000 (0.000)
Household size	0.961 (0.023)*	-0.008 (0.005)*
Location (1=rural)	0.100 (0.190)	-0.000 (0.038)
Electricity (1=yes)	1.143 (0.169)	0.027 (0.030)
Educational level	0.844 (0.065)**	-0.034 (0.015)**
Non-farm income	1.000 (0.001)	-0.000 (0.000)
Farm income	0.999 (0.000)***	-0.000 (0.000)***
Remittance (1=yes)	1.761 (0.709)	0.103 (0.065)
Constant	1.668(1.662)	
No of households	1096	1096
P > chi2	0.000	0.000
R-squared	0.0542	0.0542

Note: *, **, *** represent significance at 10%, 5%, and 1% levels, respectively; Standard errors in parenthesis.

Dependent variable equals 1 if household is classified as food insecure, and 0 otherwise

Female-headed households were about 16% more likely to be food insecure than male-headed households. This finding is similar to the vast majority of studies in the literature (Tibesigwa and

Visser 2016, Joshi and Joshi 2017, Akadiri, Nwaka, and Jenkins 2018, Kassie, Ndiritu, and Stage 2014), although as noted earlier, Mallick and Rafi (2010) found no significant difference in the food security status of male-headed households and female-headed households in Bangladesh using a generalized threshold model. A reason given for this contrary result is the lack of traditional and social limitations among indigenous groups in Chittagong Hill Tracts in Bangladesh. This affords women freedom in partaking in the labour market and other income-generating activities. In contrast, our findings are explained by the fact that in the case of Nigeria and most other developing countries, women are still discriminated against in access to most productive resources.

The estimated coefficient for land access (Column 2, Table 7) indicates that a one-acre increase in total land accessed by households reduced the likelihood of food insecurity by about 1.5%. This result is in line with those from other studies carried out in Kenya, Ethiopia and Myanmar (Muraoka, Jin, and Jayne 2018, Ghebru and Holden 2013a, Rammohan and Pritchard 2014) but disagrees with a study in South Africa that found land grant recipients more food insecure than non-recipients in land redistribution projects (Valente 2009).[7] In this case, it may be possible that the majority of households that were land reform beneficiaries were disadvantaged to start with and further burdened by relocation and travel costs of participation. In general, with more access to land and the corresponding yield and income, rural households are better equipped to combat food insecurity either by consuming their own produce or by selling their output and purchasing food with the proceeds.

The Household head having tertiary education was found to reduce the probability of household food insecurity by about 3.4% compared to those without tertiary education. Pinckney and Kimuyu (1994), Rammohan and Pritchard (2014), Tibesigwa and Visser (2016), and Akadiri,

[7] Land grant recipients had extra access to land compared non-recipients.

Nwaka, and Jenkins (2018) also found a positive relationship between the education level of the household head and household food security. This suggests that with a higher level of education, the household head may have more human capital, information, and skills needed to use the right inputs and therefore increase productivity. This may also increase participation in off-farm work and, therefore more income to purchase food.

In consonance with Gebrehiwot and van der Veen (2014), food insecurity was found to be negatively related to household size and farm income. Considering most of the households in the survey were located in rural areas, this suggests that more household members implies more family labour and hence increased farm income. This is contrary to the findings of Maharjan and Joshi (2011) and Joshi and Joshi (2017), who reported a positive relationship between household size and food insecurity. A reason for this difference may be that our sampled households have a higher number of dependents or economically inactive individuals. Households with more dependents will have a lower supply of family labour, which will have implications for their production and subsequent income.

Interestingly, the coefficient of the interaction term between female-headed households and total cultivated land (Column 2, Table 7) is negative and statistically significant ($p<0.10$). Following Allison (2014), a Wald test ($\chi^2= 3.08$ and $p<0.10$) and likelihood ratio test ($\chi^2= 4.76$ and $p< 0.05$) were carried out to compare models with and without the interaction variable. We reject the null hypothesis that the coefficient of the interaction variable is statistically equal to zero at 0.10 and 0.05 significance levels, respectively. This shows that the coefficient of the interaction variable is statistically different from zero and improves the fit of the model. The coefficient of the interaction variable indicates that even though female-headed households are more likely to be food insecure compared to male-headed households, with more access to land, they are 23% less

likely to report food insecurity. Hence, improved access to timely productive resources like land help in preventing the vulnerability of female-headed households to food shortages.

We probe the significance of the gender-land interaction variable ($p<0.10$), by computing the average marginal effect of gender of household head on household food insecurity for three different levels of land access - one standard deviation (SD) below the mean, at the mean and one SD above the mean area of land (Table 8).

Table 8: Average marginal effect of gender on food security at different levels of land access

Land access	dy/dx	S. E.	Z	P>|z|	95% CI	
1SD<$\bar{x}$	-0.249	0.138	-1.80	0.072	-0.521	0.022
$\bar{x}$	-0.238	0.132	-1.80	0.072	-0.497	0.021
1SD>$\bar{x}$	-0.216	0.121	-1.78	0.075	-0.453	0.021

Note: SD is Standard Deviation; $\bar{x}$ is mean

The estimated coefficients in Column 2 Table 8 indicates that not only at the average area of cultivated land but also for both one SD below and above the average cultivated land, female-headed households are more likely to report food security with extra access to land. Although, that probability is higher for female households with initially low levels of land access compared to those with higher access to land. Our estimated results show that the likelihood of female-headed households' being food secure increases depending on their initial area of land access. Female-headed households with a small area of land access originally, have a slightly higher probability of being food secure with increased access to land. This reveals that the efficiency by which increased access to land improves food security of households depends on the initial area of cultivated land they have access to. Improved access to land appears to have more impact in terms of increasing the likelihood of being food secure for those female-headed households that had less access originally. This agrees with most development literature (Ghebru and Holden 2013b) as households with ample access to land already may not have the capacity to make such land productive. Hence

extra access to land will not have any effect on their food security especially in times of war and conflict (Brück and Schindler 2009).

Results of the model with geopolitical zone dummies show that households in the North-central, Northwest, and Southwest are more likely to be food secure when compared to households in the northeast. Also, households in the southeast are more likely to be food insecure than household in the northeast.[8]

6.2 Estimating the interaction effect

The coefficient of the interaction variable between gender and land access in the logit model (Table7) is derived using a linear method, which does not take into consideration the non-additive effect of the interaction term over the individual effect of both gender and land variables. To overcome this problem we estimate a new interaction effect following Ai and Norton (2003) and Norton, Wang, and Ai (2004). Table 9 reports the interaction effect and standard errors by estimating the cross-partial derivatives of the expected value of food (in)security at different values of covariates in equation (1).

Table 9: Mean Interaction effect, standard error and z-score of gender-land interaction

Variable	Mean	Std. Dev.	Min	Max
Logit_IE	-0.1581	0.1196	-0.2836	0.0168

Note: Std Dev.denotes Standard Deviation

[8] This result is surprising considering the prevalence of terrorism on civilians (e.g. attacks by Islamic Militant group *Boko Haram*) and the resulting displacement in some states in the northeast zone. This finding could be a result of the lack of regional representation in the dataset, which is exacerbated by the reduction in sample size (down to 1096 households) that occurs when selecting only households that have access to arable land for cultivation. Due to the lack of data representation at the zonal level, we focus on the model without regional dummies.

Results of our logit model (Table 7) show the interaction effect to be 0.23, which indicates that with the same increase in cultivated land, female-headed households are 23% less likely to be food insecure compared to their male counterparts. After estimating the interaction effect from our non-linear model, we find the mean interaction effect is -0.158 and varies between -0.284 and 0.017. This implies that for some female-headed households, the interaction variable is negative, and for others, it is positive. The mean interaction effect reveals that with an extra one-acre of cultivated land, the likelihood of female-headed households self-reporting food insecurity decreases by about 16% compared to male-headed households, *ceteris paribus*.

This finding may be a result of female household heads being better household resource managers than their counterparts (Levin et al. 1999), even when they are disadvantaged in access to productive resources (Adesina and Djato 1997). Also, many studies have found that resource decisions made by female household heads improve the welfare of their households more than that of male household heads (Agarwal 2003, Felker-Kantor and Wood 2012, Rao 2006, Levin et al. 1999). Although, the results do show that the interaction effect could be positive for different values of the covariates, suggesting that for some female-headed households, extra access to land has no effect on their food security. This is possible when households with ample access to land do not have adequate inputs or sufficient labour to make the land productive.

To further investigate the significance of our results, we plot graphs of the gender-land interaction effect against the predicted probability of households being food insecure and the z-statistics of the interaction effect against the predicted probability of being food insecure (Figures 3 and 4). This shows how the significance and magnitude of the gender-land interaction effect varies.

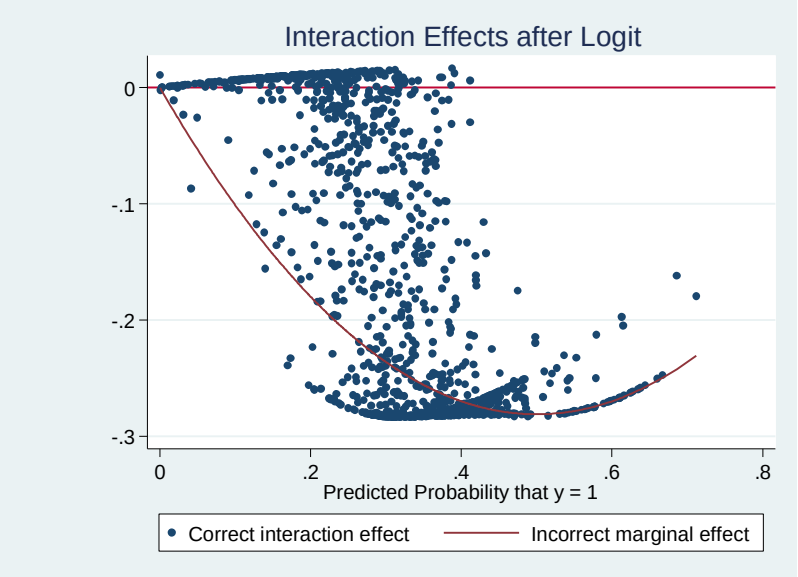

Figure 3 Plot of Interaction Effects and predicted probability of reporting Food insecurity
Source: Authors' computation

For households with the predicted probability of reporting food insecurity between 0 to 0.3 (towards the left end of Figure 3), the gender-land interaction effect is positive for some households but negative for the majority. On the right side of Figure 3, we can see that for households that have predicted probabilities of above 0.5, their interaction effects are mainly negative. This suggests that the more food insecure a female-headed household is, the higher the positive effect of extra land access on their food security.

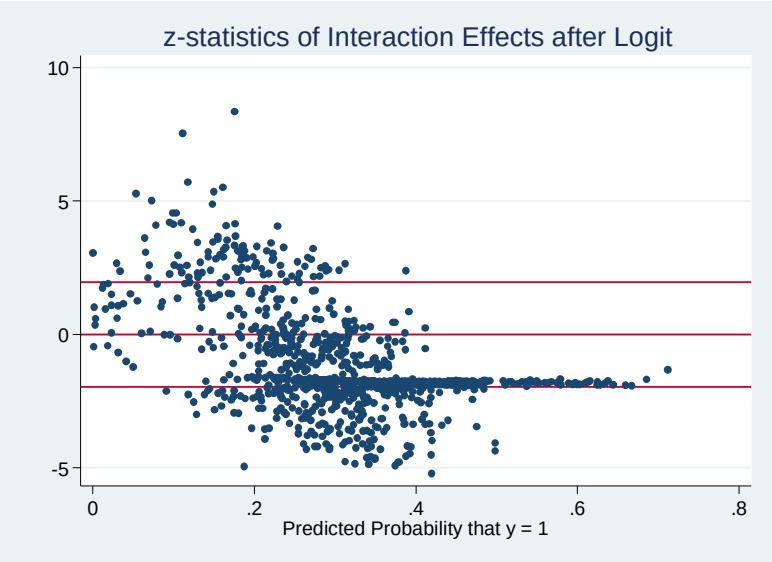

Figure 4 Plot of Z-statistics of interaction effects and predicted probability of reporting food insecurity
Source: Authors' computation

Figure 4 indicates that in terms of significance, most of the households with a predicted probability of reporting food insecurity below 0.5 have statistically significant interaction effects. On the other hand, for households with predicted probabilities of above 0.5, their interaction effects are mostly insignificant (Figure 4). Consequently, even with a significant coefficient of the interaction variable in the logit regression output, the estimation of the interaction effect based on cross-partial derivatives of food insecurity shows that not all gender-land interaction effect is significant. This implies that using only results from the marginal effects of the logistic regression output can be misleading.

7.0 Conclusion

Using Nigerian data from 1096 households, this article has extended the current literature by quantifying the joint effect of gender of household head and access to land on food security using a binary logit model. Female-headed households were found to be more food insecure than male-

headed households. Also, an increase in land access was found to diminish the probability of households being food insecure. Analysis of the non-linear interaction effect between gender of household head and size of cultivated land found that with a one-acre increase in land access for all households, the likelihood of female-headed households being food insecure decreased by about 16%, compared to male-headed households. However, our results also showed that for some female-headed households, extra access to land has no effect on their food security status. This could be because they do not have the means and resources to cultivate the land and make it productive.

The study does have some limitations. First, it does not capture possible intra-household gender differences. This is a limitation because women in both male and female-headed households may face different challenges in access to productive resources. Second, the lack of observations in some regions means that zonal differences are not accounted for adequately and thus may result in zonal misrepresentation.

Notwithstanding these limitations, the results of this study not only add to the literature but also have implications for policy and food security interventions. First, it emphasizes the need for gender equity and equality in accessing land in order to ensure food security. Second, the findings can help inform policy implementation around issues of land access and land tenure systems, not only in Nigeria but also in other developing countries in support of the fifth SDG for gender equality and empowerment of marginalized rural women and girls.

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